Generative Mechanisms of Technology Enabled Transformation: A Critical Realist Evaluation of a Hospital Laboratory Unit Transformation

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Short Paper

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Abstract

Digital transformation success remains elusive and therefore a domain worthy of developing better evidence. Advancing understanding of generative mechanisms – the underlying causal powers that explain digital transformation – would be extremely valuable insight for practice. Substantial opportunity continues to exist to explore how exactly a transformation process unfolds and how organizational structural objects that inscribe social and technological agency, intertwine with each other and with the action of actors to cause transformation. Focusing on generative mechanisms, this research used grounded theory to study a hospital laboratory unit involved in transformation efforts. Using critical realism ontology, preliminary analysis uncovered five plausible key generative mechanisms: Framing of need; Forming the need; Materializing critical thinking; Validating; and Actualizing affordances. Follow-up data and analysis will formalize a generative mechanism model of transformation. The article concludes with expected contributions and suggested future work of this study.

Keywords: IT enabled transformation, Critical realism, Generative mechanisms, Causality

Introduction

The complexity and struggles involved in undertaking transformative efforts is discernible from recent industry based reports. A global survey by McKinsey, conducted among company executives from several industries shows that only 26% agree that the transformation efforts they were part of were successful (McKinsey Global Survey, 2015 - Bucy et al, 2016). Additionally, a 2018 industry survey of digital process automation by Forrester research firm suggests that although many businesses believe that automation of their processes is key for achieving end-to-end digital transformation, managers still end up relying on manual interventions to carry out their processes due to struggles in making necessary adjustments (Forrester Survey - Koplowitz et al, 2018). These practitioner survey findings further suggest that undertaking transformation is an extremely complex process for organizations. Thus we observe that while most organizations are aware of 'what to do' in theory, they nevertheless experience much greater uncertainty and variability on 'how to do it' in practice. The low success rate of transformative efforts suggest that scholarly explanations seeking to obtain concrete actionable insights should emphasize causal factors underpinning transformation as a means to establish the ways in which different organizational resource arrangements enable attainment of intermediate goals during transformation.

The study intends to identify the generative mechanisms underlying the transformation of an organization towards its digital transformation goals. *We address the question - what generative mechanisms act as causal forces in enabling the evolution of transformation over time?.* In order to understand the emerging nature of transformation processes and how different structural objects – in particular social and technological, coalesce to achieve the transformation vision, an in-depth qualitative study of a hospital's laboratory unit undergoing a transformation journey is undertaken following grounded theory methodology. In order to guide this research, an ontological perspective of critical realism is adopted. With this ontology we believe that the complexity involved in IT enabled transformation's generative mechanisms can be best apprehended via observations of actual events in the setting and then retroducing to identify the ways in which these events were manifested through different structural objects. Exploration of the emergence, use of and consequences of these structural objects allow us to retroduce and conceptualize underlying causal mechanisms. In the next section, we present an overview of IT enabled transformative change along with a background on the ontology of critical realism and generative mechanisms. Subsequently we review the details of the case setting and data collection process and this is followed by presentation of preliminary findings. Finally, the article ends with expected contributions and explanation of future work planned for this study.

Conceptual Basis and Related Research

Transformative Change

Change either small or large - can be gradual or radical, slow or fast, and can involve substantive or limited planning (Besson and Rowe, 2012). Additionally, Venkatraman (1994) suggest that these changes may focus on surface level aspects of change - such as improving efficiency of operations, or change in relation to more drastic levels such as re-defining the operations or business network or the business scope itself. The later type of drastic changes are usually considered to be transformative in nature i.e., a transformative change involves alteration of ways through which an organization carries out its business and delivers its services going forward (Besson and Rowe, 2012). Predominantly, researchers study transformation from the paradigm of strategic alignment where an organization transforms itself using IT by aligning the business and IT strategy (Henderson and Venkatraman, 1999). Such an approach suggests that the end in the transformation journey can be known ahead of time and that proper strategic steps can be taken to achieve the end goals (For ex: Kotter, 1995 stages or different strategic-IT alignment approaches of Henderson and Venkatraman, 1999). In contrast, evolutionary theorists suggest that an organizational transformation emerges in various ways: 1) from within an organization either in a gradual way based on situations (Orlikowski, 1996; 2000); 2) in a rapid way as it pulls itself back into a state of equilibrium when it suffers from internal misalignments (Romanelli and Tushman, 1994; Gersick, 1991); 3) when it faces an external environmental pressure (Romanelli and Tushman, 1994; Gersick, 1991). At the phenomenon level though, a central theme of transformative change is that it represents an alteration of an organizational system's deep structures which are constituted by its units and activity patterns among the units (Gersick, 1991). In contrast to normal IT driven change which tends to focus on how a particular organizational entity is improved using IT, transformative change involves simultaneous changes among several organizational entities that constitute the system's deep structure where multiple technologies could be involved in such changes. In order to put a perspective on the process of transformation, Besson and Rowe (2012) describes that the transformation process itself progresses through four phases - uprooting, exploration/exploitation, stabilization and optimization. The authors suggest this process through a synthesis of Lewin's organizational development model of – unfreeze, move and freeze and punctuated equilibrium model of – convergence and upheaval (Tushman and Romanelli, 1985).

Although transformative change is complex in nature, nevertheless, the deep structural alteration could be understood by focusing on fundamental organizational components of – people, technologies, tasks and organizational structure (Leavitt, 1965) that make up the different activity patterns in such deep structures. Considering these components are indicative of social and technological structural objects and the rules they operate under, theorizing transformative change requires theorizing how these social and technological structural objects interact with each under various contextual conditions to alter a deep structure's existing activity patterns. Uncovering such micro-level associations among structural objects and their pathways of change will show how and why transformation efforts alter an organizational system's existing deep structure towards transformation goals.

Empirical Focus of IS Research on Transformation

The phenomenon of transformative change involves end to end alteration of an organizational system and its activities rather than surface level improvements of that system. Although not explicitly identified, research in IS adhering to this principle has been undertaken in several subdomains and at different unit of analysis. For instance, research has focused on: explaining the transformation of government program delivery using electronic channels (Mahrer and Krimmer, 2005); business processes such as revenue cycle transformation using IT (Singh, Mindel and Mathiassen, 2017); and efforts of an IT department to reinvent itself to become a strategic driver in large scale organizational transformation (Wastell, McMaster and Kawalek, 2007). Interestingly, besides studying transformation of a particular business process or a service program or a department, research has also focused on individual and group cognitive transformations. For instance, explanation was provided to show how users' agency was transformed over time so that the implemented ERP system was used as per the transformation agenda set by the organization (Boudreau and Robey, 2005). In another instance, a study focused on how group thinking was transformed in terms of their commitment towards handling a failing project using Lewin's theory of change (Pan, Pan, Newman and Flynn, 2006). The above studies suggest that whatever the focus is – either individual, group, business process, functional unit or a government initiative - the principle of transformation i.e., altering the existing way of doing things or the deep structure (relative to the focus of this study) appears to have been followed. Further, these studies also involved dealing with social and technological structural objects operating under different rules depending on the focus of transformation.

Methods used to study transformation have mostly adopted qualitative approaches to explain the observed transformation. Although rich in descriptions, such studies nevertheless lack a careful delineation of involved structural objects that comprise the system, their actions and the temporality aspect of the evolution. The lack of such focus has also been expressed as a concern by Besson and Rowe (2012) where the authors' review of IT enabled transformation research revealed that there is no knowledge on "….the mechanisms that explain the changes in the stages and how events and actions unfold" (p.114) during the process of transformation. Therefore, in order to understand how an organizational system can integrate different structural objects in ways such that the transformation vision is achieved, this study uses critical realism to investigate a hospital business unit that is currently undergoing transformation. We next explain why we use a critical realist ontology to underpin our orientation towards our phenomenon and methodology.

Critical Realism and Generative Mechanisms

The ontological philosophy of critical realism puts forward the notion that any phenomenon consists of three strata. These are real, actual and empirical. This philosophy, first advanced by Roy Bhaskar (1978), proposes that there is a real world that exists out there which we are not aware of completely and that our awareness of it is only constructed and hence could also be fallible. This 'real' layer is also associated with mechanisms referred to as 'generative mechanisms' that result from several structural objects present in the same 'real' layer (Bhaskar, 1978). In turn, these generative mechanisms cause events of a phenomenon which exist in the 'actual' layer, some of which we experience in the 'empirical' world (Bhaskar, 1978; Volkoff and Strong, 2013; Sayer, 1992; Easton, 2010; Bygstad, 2010; Blom and Moren, 2011). As a result, when adopting a critical realist perspective to understand something, the focus moves from pure events or outcomes that are observed to the underlying mechanisms that cause or constrain those events (Blom and Moren, 2011). Further, critical realism also suggests that since our knowledge may or may not appropriate the 'real', the goal of using this ontology is to approximate the reality as close as possible (Bygstad, 2010).

Several generative mechanisms have been suggested as a way to understand different types of phenomenon. For instance, Henfridsson and Bygstad (2013) identified the mechanisms of – adoption, innovation and scaling as instrumental in the evolution of a digital infrastructure. In other research, Bygstad (2010) suggests two recursive mechanisms through which information infrastructures lead to innovation in ICT-based services. These are: the 'innovation mechanism' which leads to new service creation; and the 'service mechanism' which leads to creation of more users and profits. Additionally, Volkoff Strong and Elmes (2007) suggest the mechanism of 'technological embeddedness' as a cause for bringing about organizational changes using enterprise system, especially in routines and roles. Further drawing similarities to critical realism philosophy, Volkoff and Strong (2013) also suggest that technology based affordances are in fact generative mechanisms existing in the 'real' layer of the world. What this means is that the powers inherent

to different social and technological structural objects have the potential to cause different phenomena based on the ways they interact with each other. Hence, explicating generative mechanisms is not only insightful in terms of obtaining micro-level details on the actions performed by the involved structural objects, it also helps us understand the causal path in the evolution of the observed phenomenon.

Viewing the phenomenon of transformation from a critical realist standpoint helps in two ways. First, this ontological perspective does not reduce the complexity and nuance to broad assertions about a step-wise description of change. Second, critical realism does not claim to unearth all the possible causal forces that contribute towards manifestation of events in the transformation process but suggest a limited focus on explicating a few key central mechanisms that efficiently explain the observed events in the phenomenon (Wynn and Williams, 2012). In the end, studying technology enabled transformation from a critical realist standpoint allows us to shift the focus towards structural objects and their inter-relationships. Hence, given the need for understanding the micro-level dynamics of transformation and more specifically to achieve the objective of explicating generative mechanisms, an in-depth case study methodology was judged an appropriate approach. We discuss details of this approach next.

Methodology

A case study methodology enables understanding the trajectory of the transformation process in more detail. An in-depth study of a major hospital in Canada, currently in process of transforming its core laboratory services business unit is undertaken following grounded theory methodology techniques (Glasser and Strauss, 1967). This allows us to develop a generative mechanisms view of transformation and understand how they act as causal forces in transforming an organizational unit. Additionally, the approach helps us understand how social and technological objects coalesce to achieve transformation vision in detail.

Case Background: The initiative of lab unit transformation was envisioned after the integration of hospital services and lab services across a hospital network following new legislative regulation in Ontario Canada. Following the wave of changes that occurred across the hospital network, a particular hospital i.e., LifeHospital (pseudonym) decided to transform its core laboratory services unit referred to here as CoreLabs. This required re-designing several things concurrently including CoreLabs physical layout, installing new sample analyzer instruments and sample automation tracks, and storage, all of which was integrated with new software systems thereby changing the information flow to the patient chart as well. This effort included re-designing the way patient sample were collected and pre-analyzed, the testing that would be operationally performed and the way test results are uploaded to a patient chart. The decision was made since the hospital and the lab unit wanted to support efficient and faster processing of samples, provide new testing menu options for patients, improve the lab's technological capabilities to handle any new medical tests in future and reduce the number of patient samples collected for testing purposes. The transformation vision was established in mid-2016 and the execution began in late 2017. At the end of 2018, the execution phase of transformation was completed leading to a stabilized lab state at which point, the focus of transformation shifted towards realizing the benefits.

Data Collection: The collection of data began by first engaging with top level management during Jan 2018 to understand the type of changes this initiative was undertaking and how this transformative change was different than previous other cycles of change that the lab went through. Upon understanding the initiative, the study proceeded to gather more in-depth insights into the transformation efforts. We used multiple ways to collect data: interviews, participant observations, informal conversations and secondary data. We conducted 40 interviews with 26 participants during field work from January 2018 to April 2019. The participant designations includes – the director, manager, lab coordinator, section head of biochemistry, program head for hematology, senior medical lab technologists (Sr. MLTs), junior MLTs, lead MLTs and MLTs responsible for maintaining lab information system (LIS)/middleware systems. Due to the highly technical nature of the setting, close to 100 hours of observation was completed in the laboratory. During this time, informal conversations (over 100) were completed with the lab staff. Although the access to carry out observations was granted after the new automation instruments went live, nevertheless, observations and informal conversations further supported the data obtained from interviews since they shed light on micro-level actions that the ground level MLT staff performed as soon as the automation went live.

Data Analysis Procedure: The data analysis proceeded as follows. First, a timeline of events was mapped and divided into phases from 2016, the year when transformation vision was crafted, to 2018 when final set

of automation equipment were placed in the laboratory. Second, key structural objects falling into the categories of – social and technological that were part of the events were identified along with structural rules. Third, after identification of key events under each phase, analysis was performed to explicate the process that was followed to accomplish the events – specifically for the events that involved commissioning of new instruments. Fourth, the analysis focused on explicating key mechanisms that contributed towards the occurrence of each key event in each phase. Considering the complexity of the phenomenon, close attention was also paid to different situational contexts under which the actions constituting the mechanisms manifested. Coding followed initial and axial coding techniques (Strauss and Corbin, 1998) while constantly comparing the emerging theoretical categories (Glasser and Strauss, 1967).

Initial Analysis Findings

Events

A timeline of the transformation evolution with key events is shown in Figure 1 below.

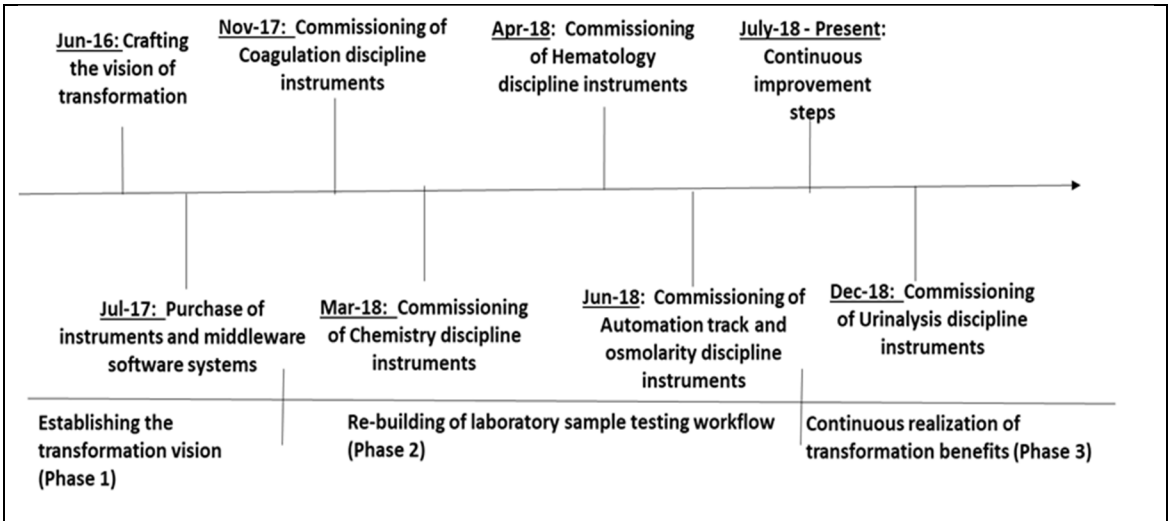

Figure 1: Timeline of Key Events during Transformation

The three phases that are categorized in the above timeline provide key milestone events during the journey of transformation. Although the events in each phase look discrete, they should be understood in conjunction since each phase moved transformation ahead and involved close interactions between different structural objects mainly social and technological. The explication of mechanisms focused on identifying few key ones that together enabled transformation evolution.

Phase 1 events of "Establishing the transformation vision" (refer to Figure 1) resulted in three outcomes: a) a new transformation vision was established b) vendors were selected and c) sample tests types were divided into 5 disciplines of – coagulation, chemistry, hematology, osmolarity and urinalysis. While phase 1 was mostly managed at a macro level by top management, Phase 2 events of "Rebuilding of laboratory sample testing workflow" involved ground level laboratory staff, at a micro level, focusing on altering sample testing process from a siloed discipline specific workflows towards an integrated workflow using software systems. The end of phase 2 resulted in transformation of the physical layout of the lab as well as creating an integrated sample testing workflow structure in the lab. Phase 3 events of "Continuous realization of transformation benefits" allowed the lab unit to focus on realizing the benefits offered by the new automated workflow and software systems. These benefits indicate the organizational level impacts caused from actions at the micro level by lab staff.

Each phase of the transformation journey moved the vision from concept to execution with 'CoreLabs' realizing the benefits from digitally transforming their sample testing processes. Along the way, data analysis uncovered several key generative mechanisms starting with phase 1 at macro level involving mostly

top management and other managers to phase 2 execution of the vision by the ground level MLTs at a micro level leading to translation of benefits from micro level to macro level in phase 3. Phase 1, included 2 mechanisms: 1) "Framing of need - to explain the need, the goals in a different way to staff to alter their thinking"; 2) "Forming the need - signifying the foundational steps taken before the actual beginning of the execution of transformation vision". Phase 2 included 2 mechanisms: 1) "Validating - signifying authenticity of instruments produced sample test results against quality criteria" and 2) "Materializing critical thinking" (explored in detail below). Phase 3 benefits were realized through "Actualizing affordances" possible from new software middleware systems. Each affordance could be considered as its own generative mechanism (Volkoff and Strong, 2013). An example affordance that emerged include – "Monitoring - utilizing new software middleware systems to track each and every sample along the automation line". These causal mechanisms allowed the evolution of transformation at this setting.

To conserve space yet provide detail, we present below in rich detail how our analysis uncovered the generative mechanism of 'materializing critical thinking'. We applied the same data analytic process to build insight and evidence for the mechanisms outlined above.

A Generative Mechanism Example: Materializing Critical Thinking

Phase 2 events focused on commissioning of different discipline specific instruments and integrating them on the complete automation line. A mechanism that manifested to cause these events is explained below. The retroduction process followed critical realist analysis process suggested by Wynn and Williams (2012) which included: 1) Explication of events 2) Explication of structural components and context 3) Retroduction 4) Empirical Corroboration – all by relying on triangulation.

Step 1 - Event: Phase 2 events involved executing the vision of transformation by the laboratory staff of medical lab technologists (MLTs) through commissioning of instruments for each discipline. The process of commissioning proceeded simultaneously for all the disciplines. As a result, the explication focused on a mechanism that ensured these events were successful in the end and achieved their purpose.

Step 2 – Structural components and Context: The primary structural components that mattered at this stage of transformation were medical lab technologists (MLTs); middleware software systems; lab information system (LIS); and quality management guidelines. One of the primary aspect for the successful commissioning of instruments involved writing decision making rules in middleware software systems to control the sample testing process and instruments on automation track. The decision making rules were to increase the sample testing speed through auto-verification of results against the quality criteria. This formed the primary context at this stage of transformation.

Step 3 – Retroduction: The interplay among the above identified structural objects were closely explored. The structure of the 'CoreLabs' ground level staff involved junior medical lab technologists (MLTs) to lead MLTs to senior MLTs. Nevertheless, the culture during this phase was very informal and collaborative in nature due to uncertainty prevailing over the unfolding of events and situations. This is the first time that the 'CoreLabs' was entirely transforming in the way they process and deliver patient sample test results to the patient chart. MLTs worked together with the group responsible for writing decision making rules, who were also MLTs by training, following quality management guidelines.

Interview data, data from several informal conversations and observations suggested a micro-level mechanism of *'Materializing critical thinking'*, where MLTs became more of peripheral decision makers with middleware software systems rules becoming the core decision maker, as instrumental in causing the commissioning events. The mechanism involved several actions in its manifestation. Firstly, MLTs examined closely the existing testing procedural rules handled by lab information system (LIS) which was central system in managing 'CoreLabs' operations. As an MLT explains on the examination of existing procedures and the details associated with it - *"Different instruments, they may have a different reference ranges, different criteria as to linearities of methodologies. Also the label, when you order up a test, it's a little bar-coded label for nursing to collect the samples, for that kind of identifies what the sample type is, the volume and where it's supposed to go. So it impacts collection requirements, it impacts routing, it impacts reference ranges and any interpretations, possible calculation".* Secondly, new decision making rules were embedded in the middleware systems. As the lab manager explains on the type of rules that were written for instance - *"The thing about middleware and WAM [a middleware system] is the amount of rules that we can write. It's so big on that particular discipline of hematology, we need to write a lot of*

rules. So if we think about cancer patients who have extremely low white counts and they don't have a lot of white cells, for us to do a...it's called a manual differential on those, it takes a long time. We can write rules that says, only on mondays' do we do a differential on a cancer patient located on Ward C 7... we can write that rule in WAM and eliminate a lot of unnecessary work". Thirdly, as part of continuous improvement, the MLTs focused on refining the written decision making rules in middleware systems constantly in order to further speed up and reduce redundancies in testing process. As an MLT explains *"What we're doing is we're looking at the decision rules or the rules that are being maintained and facilitated through our middleware ...constantly revising and tweaking and fine-tuning."*

Step 4 – Corroboration: Corroboration is sought in several ways by relying on multiple participants, repeated confirmations with participants over extended period of time and different sources of data. The mechanism's functionality was explained in its importance to participants and were asked to comment for further refinement. Further, the similarity of commissioning of discipline specific instruments suggest that this mechanism's actions of examining, embedding and refining were crucial in successful achievement of all observed events.

The above mechanism also signifies the change in organizational structure of the 'CoreLabs' from having a siloed discipline testing workflow and dedicated MLTs to an integrated automated workflow with MLTs now cross-trained across all disciplines.

Evolution of Transformation

The witnessed evolution of the transformation at this setting involved a mix of both strategizing and organizing simultaneously. The decentralized planning approach adopted by the top management moved away from the traditional approach of top down strategizing that lab followed during earlier cycles of change. This strategy paved the way for formative mechanisms of phase 2 which resulted in lab moving from a siloed operational unit towards an integrated unit. The re-building efforts of phase 2 allowed the staff to further perceive several opportunities provided by the new technologies and capitalize on them as part of continuous improvements. The unfolding of the phenomenon also represents the morphogenesis (Archer, 1995) of the lab structure where the initial lab structure was transformed into a new structure through different social interactions happening at the top management level and ground staff level in the form of generative mechanisms as shown in Figure 2.

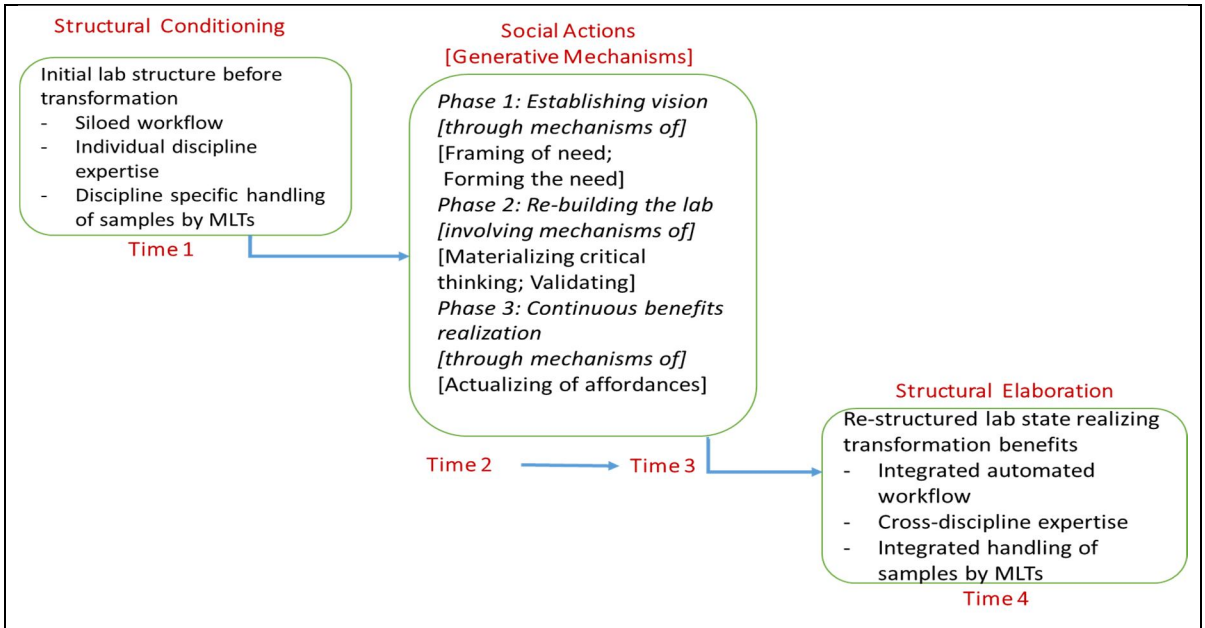

Figure 2: Evolution of Transformed State of the Lab Unit

Further looking closely at the generative mechanisms, they follow a macro-micro-macro model (Coleman 1994; Hedström and Swedberg 1998) where 'Framing of need' and 'Forming the need' during phase 1 allowed transformation to move to phase 2 during which 'Materializing critical thinking' and 'Validating' mechanisms manifested leading to realization of benefits by MLTs in phase 3 through 'Actualizing affordances' in turn translating into macro level organizational benefits.

Expected Contributions and Future Research

This research study and analysis is on-going. As a result, the theoretical model as well as the explication of the mechanisms will be further elaborated on after further analysis. As part of future work, the contextual characteristics as well as the actions constituting each mechanism will be explained in more depth. Additionally, the changes that occurred in each discipline due to each event will be further analyzed to provide insights into how automation and middleware systems exactly altered each discipline's workflow i.e., its deep structure. In doing so, the significance of generative powers of social and technological structures will further come to light. Future work will include more detailed and elaborated descriptions of data analysis and the process of retroduction for each mechanism than is possible in a short paper format.

This in-depth study on evolution of IT-enabled transformation aimed to provide insights into the associations among different social and technological entities during transformation process. In doing so, the study develops a generative mechanisms view of the transformation phenomenon. By doing this, the study contributes to the literature in the following immediate ways. First, the study provides micro level details on the journey of transformation focusing on the social and technological structural interactions under different contextual conditions rather than limiting to only description of events which only captures the stage wise transformation evolution. Second, the mechanisms also show the inter-dependencies during evolution suggesting that the activation of certain mechanisms require activation of earlier mechanisms. Third, this study also hints that although hospital information systems and electronic health records adoption influences patient care improvement, the lesser known or behind the scenes laboratory units also play a huge role in improving patient care and hence require technological improvements as well.

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